



Introduction to Technology & Opportunities

December 2017



- Core Competencies
 - Invention Development - Material Engineering – mechanical /chemical engineering
 - Financial Modeling – Cost Accounting/Scenario Development (Multiple Industries)
 - Strategic Relationships & Business to Business Sales
- Patent portfolio
 - 5 issued patents
 - 40+ applications
- Technologies
 - **RCU**
 - Surface Treatment
 - Food Safety



**12" RCU Drying 65% MC
Douglas Fir Sawdust**

Introduction to High Pressure Frictional Pyrolysis



4 minutes, 20 seconds

FRICION & PRESSURE

BIOMASS

SOLID
CARBONACEOUS
BIOFUEL

400-650°F (204 – 343°C)
15-29 Bar (217-420 psi)

FEEDING

FRICION SCREW

REFLUX CONDENSER

STEAM EXPLOSION → PYROLYSIS → RECAPTURING → AFTERCOOLING

Method to thermally upgrade wood and non-woody biomass for coal replacement

Production Size -- 12" RCU with Reflux Condenser



**Demonstration 12"
Rotary Compression Unit**

**Over 1,000 Hours of
Operation**

Engineered Solid Fuel – BioCoal™ Fuel

Pallet Lumber (L) and BioCoal™ Fuel (R)



Mixed Biomass BioCoal™
Fuel Briquettes

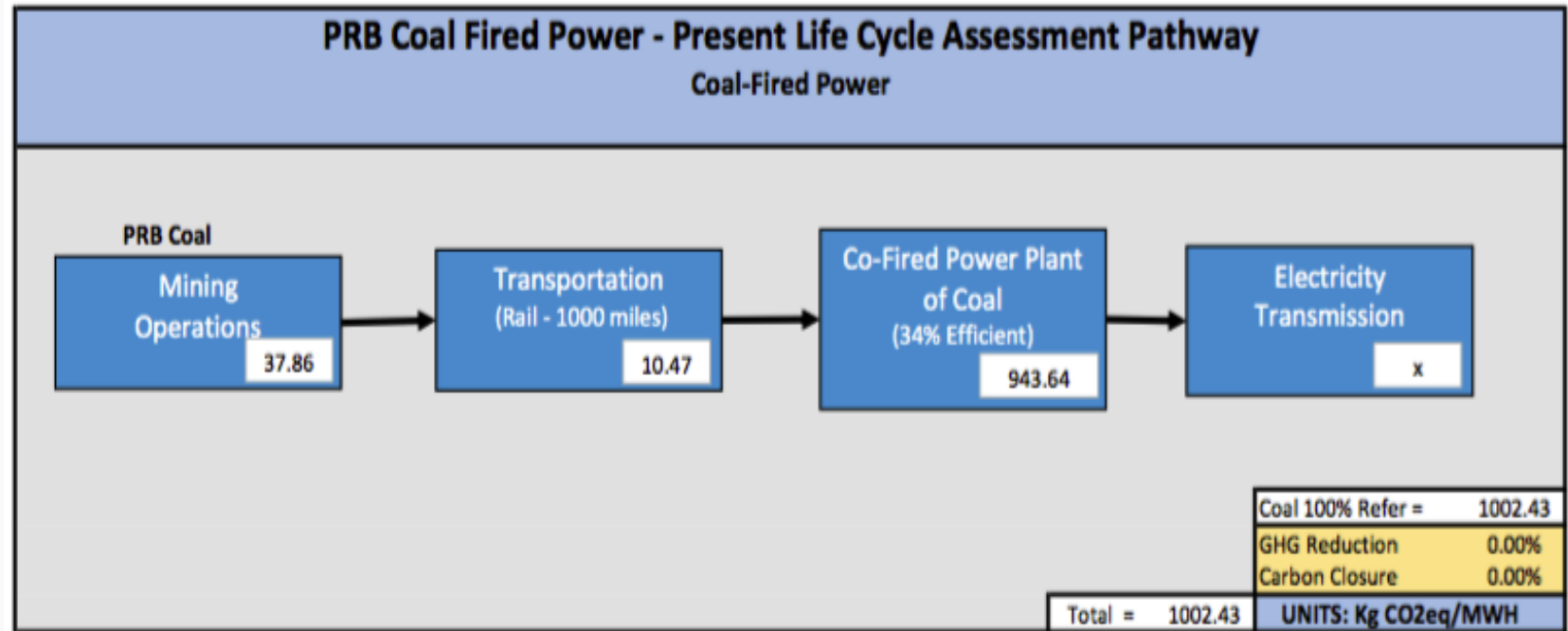


- Novel method of pyrolysis via friction and pressure
- Continuous, not batch
- Process time is less than 4 minutes, 20 seconds
- Increased Carbon and Fixed Carbon
- Multiple and diverse inputs, allowing cost management
- Homogeneity and BTU content similar to coal

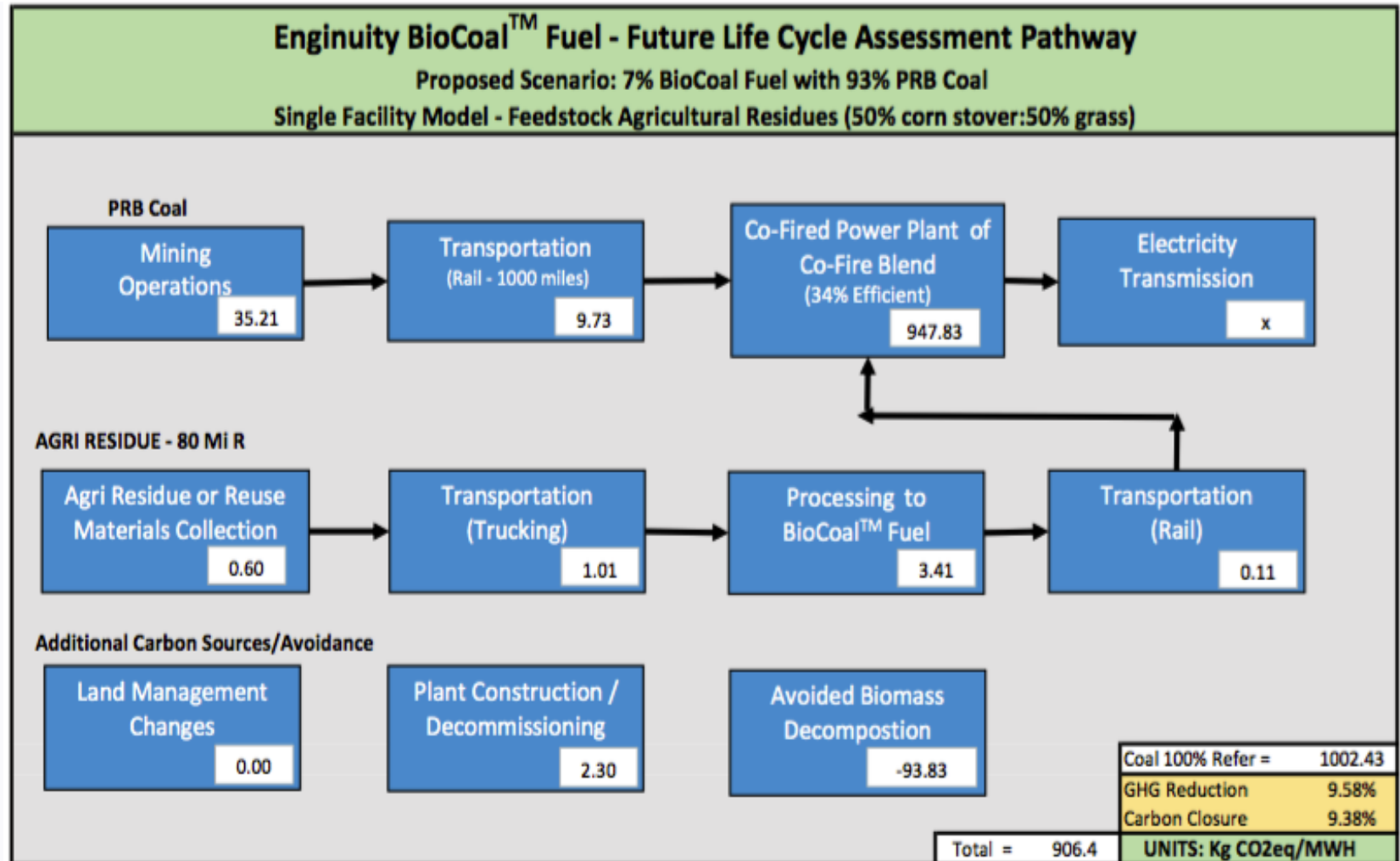


BioCoal™ Fuel
Tablets - Cedar

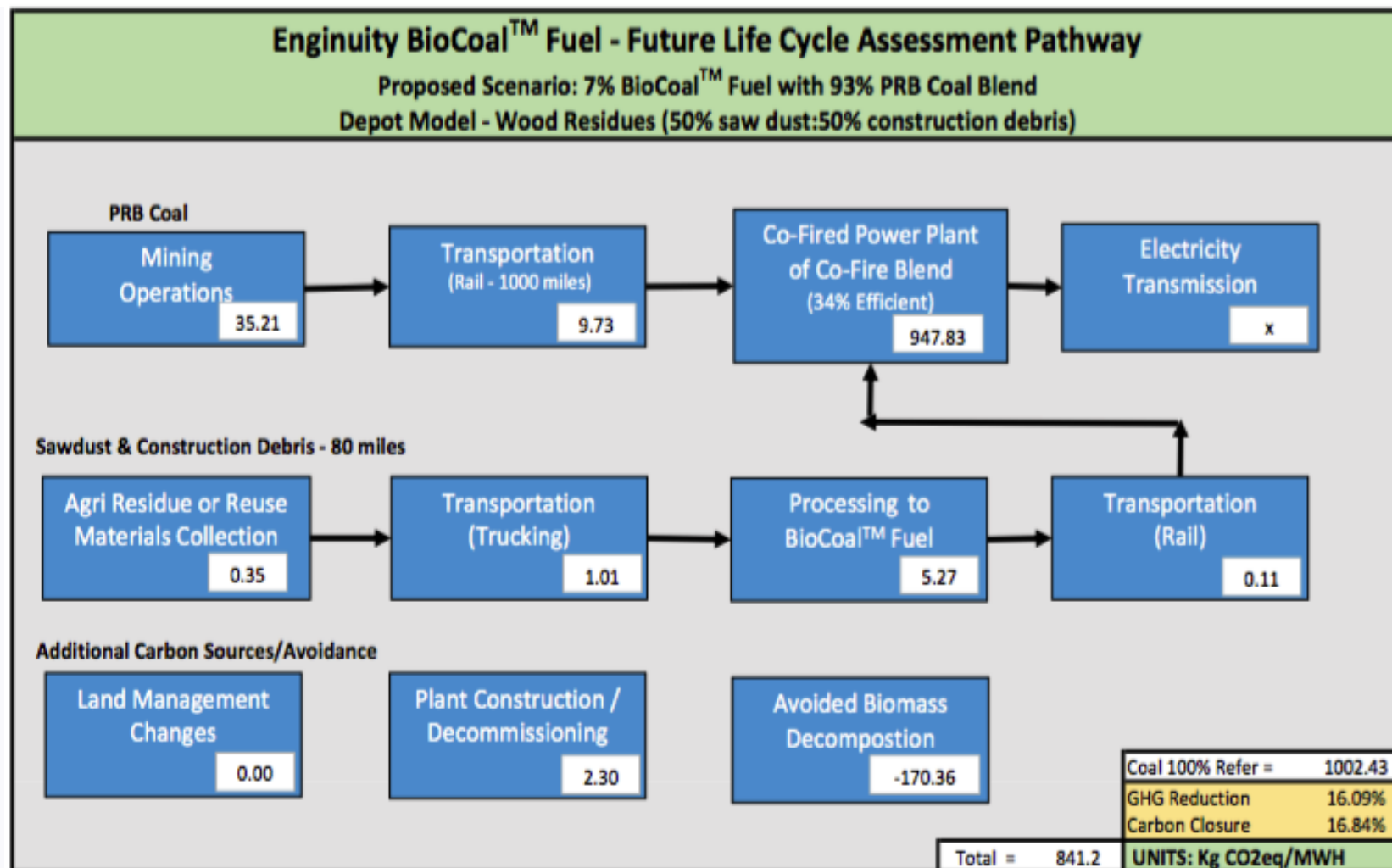
Feasibility Report | Carbon Benefits – LCA Approach -- BASELINE



Feasibility Report | Carbon Benefits – LCA Approach



Feasibility Report | Carbon Benefits – LCA Approach



Enginuity BioCoal™ Fuel

Cost: Benefit Analysis

- Cost of BioCoal™ Driven by Feedstock Logistics. NOT heavy on process costs.
 - FUEL: Typical Fuel Costs -- \$3-7/MMBTU - \$0.03-0.07/kw-hr
 - Fuel Price Driven by Feedstock and Supply Directives/Limitations
 - Addition of “waste” feedstocks to lower overall fuel price
 - PLANT: Minimize Retrofit at Power Plant
 - Use of Existing Assets to Manage Power Generation Investment
 - Engineer the Fuel to Fit Existing Coal-Fired Generation
- Benefits at All Levels
 - POWER PLANT:
 - Reduced Emissions – Baseload Renewable
 - Co-Fire Strategy Potential Benefit Power Plant Operations
 - RURAL COMMUNITIES: Jobs stay in place in Rural Arizona – Keep Existing Assets at Work.
 - FOREST: Biomass Utilization from Forest Stewardship is Key to Forest Management
 - Referenced in APS Study to be \$2/ MMBTU (\$0.02/kw-hr)
 - STATE-WIDE ENERGY PORTFOLIO: Baseload Renewable, Carbon Beneficial
 - TECHNOLOGY BRIDGE:
 - Solves timing and capital cost of new biomass boiler construction.
 - Solves moisture and handling challenges associated with chips.



Arizona Initiatives & Recommendation



- Upper Verde Watershed – West Side
 - USDA Woody Innovation Grant
 - Drake Cement ID'ed as user of BioCoal™ fuel
- SRP – East Side
 - Initiated Phase 1 of Collaboration
- Enginuity Team – State-Wide Impact
 - Support Biomass Use in Power Generation to Preserve Forest and Watershed
 - Assembled Team of Biomass Procurement, Equipment Manufacturing, Technology, Architects/Engineers, and Owner/Operators.

Consider engineered, densified, and upgraded fuels as part of the solution to solve Arizona's biomass problem.

Enginuity BioCoal™ Fuel is a good fit for upgraded fuel portion because the cost-effectiveness of the technology.